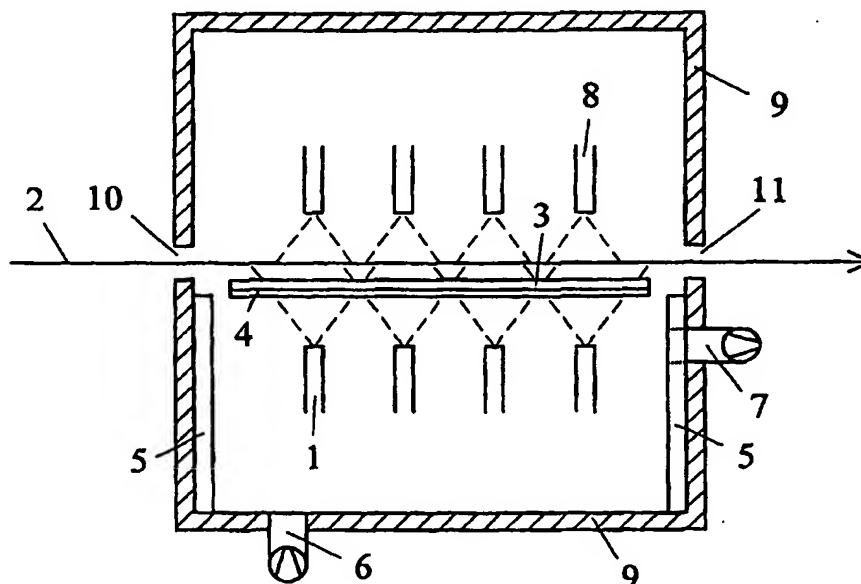


PCTWORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : D21H 23/50	A1	(11) International Publication Number: WO 00/42254
		(43) International Publication Date: 20 July 2000 (20.07.00)
<p>(21) International Application Number: PCT/FI00/00026</p> <p>(22) International Filing Date: 14 January 2000 (14.01.00)</p> <p>(30) Priority Data: 990091 18 January 1999 (18.01.99) FI</p> <p>(71) Applicant (for all designated States except US): VALMET CORPORATION [FI/FI]; Fabianinkatu 9 A, FIN-00130 Helsinki (FI).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): VÄHÄKUOPUS, Mika [FI/FI]; Franzeninkatu 3 A 21, FIN-00500 Helsinki (FI). NISSINEN, Vilho [FI/FI]; Onkimaantie 195, FIN-04660 Numminen (FI). LUOMI, Seppo [FI/FI]; Purukuja 2 A, FIN-04440 Järvenpää (FI).</p> <p>(74) Agent: SEPPO LAINE OY; Itämerenkatu 3 B, FIN-00180 Helsinki (FI).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published With international search report. In English translation (filed in Finnish).</p>

(54) Title: SPRAY-COATING METHOD AND SPRAY-COATER



(57) Abstract

The present invention relates to a method and apparatus for coating a moving paper web (2), in which method the web (2) to be coated is passed to a coater station and the coating is applied to at least one surface of the moving web (2) by means of spraying nozzles (1) disposed in the interior of an enclosing hood (9). The web (2) is supported noncontactingly by means of air jets directed toward at least one side of the web (2).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

Spray-coating method and spray-coater

The present invention relates to a spray-coating method according to the preamble of claim 1 and a spray-coater
5 according to the preamble of claim 15.

Coating paper with a pigment slurry is performed by applying a smooth layer of coating to the surface of a paper web, after which excess water is removed from the web by means of dryers. Over the times, the application and leveling has been carried out with the help of different apparatuses, whose development has been directed by the increasing requirements toward higher quality and productivity, as well as faster web speeds in papermaking
15 machines.

One technique suitable for use in coating a paper web is the so-called spray-coating method that is described, e.g., in the international patent application publication
20 WO 97/13035. In the spray-coating technique the coating mix is applied to the surface of paper web by spraying nozzles in which the coating mix is atomized into small droplets prior to spraying onto the moving paper web. The coat quality can be controlled by adjusting the distance
25 between the spraying nozzle and the web, the spray-jet velocity and the mass rate of spraying. Generally, there must be disposed a number of spraying nozzles in the cross-machine direction to the web travel, because the coverage of the spraying jet emitted by a single nozzle
30 is usually narrower than the width of the web being coated. Typically, there is disposed a number of nozzle rows across the web, perpendicular to the web travel, since a single row of nozzles extending across the web usually fails to provide a coating of a sufficiently high
35 quality. The coating mist not adhering to the web during the coating process can be recovered for reuse. To prevent the coating mist from escaping to the environ-

ment, the spraying nozzles are generally located in a closed space such as an enclosing hood.

After the application of the coating, the paper web must
5 be dried in a noncontacting manner because the wet
coating is sensitive to mechanical contacts. Generally,
the noncontacting drying is carried out using infrared or
air-impingement dryers. Cylinder dryers can be used only
10 after the coating has attained a sufficiently low
moisture content and will not any more adhere to the
cylinder.

Conventionally, the coating is applied to the surface of
the paper web in several steps, and the paper web may
15 also be subjected to further drying between the succes-
sive application steps. This kind of a coater station
involving a plurality of applicator/dryer devices
requires a lot of space which complicates its integration
with a paper machine. One of the problems to be solved in
20 the spray-coating of paper sheet is how to apply the
coating emitted from the spraying nozzles so as to attain
a uniform coat weight and quality at both the center and
the edges of the paper web. Usually, the applied coating
layer at the edge areas of the coated paper web tend to
25 be thinner than at the center area of the web, whereby it
will be problematic to reach a smooth coat profile up to
the web edges. Because the gap between the moving web and
the enclosing hood is difficult to seal, it is also
impossible to fully prevent the coating mist from
30 escaping to the environment from the hood enclosing the
spraying-nozzle assemblies. The spreading of the coating
mist to the exterior of the enclosing hood can be reduced
by using vacuum suction to remove the coating mist from
the interior of the hood and then to separate the coating
35 solids from the recovered coating mist for reuse.
However, these kinds of arrangements need a separate
filter for recovering coating solids from the mist. The

coating mist filling the interior of the enclosing hood also tends to readily adhere to and dry on the surfaces such as the spraying nozzles housed in the interior of the hood.

5

It is an object of the present invention to provide a novel type of spray-application method and apparatus capable of overcoming the above-described problems.

10 The arrangement according to the invention replaces a roll or wire conventionally used for supporting the web by air jets directable to the surface of the web. Additionally, air jets may be used for drying the coating applied to the web surface. Furthermore, edge deckles are
15 disposed close to the web edge between the spraying nozzles and the paper web that serve to prevent coating sprays discharged from nozzles close to the web edge from reaching the web surface at the edges. With the help of an exhaust nozzle connected to the hood enclosing the
20 spraying nozzles, the interior of the hood is brought to a partial vacuum relative to the ambient pressure thus preventing the coating mist from escaping to the exterior of the hood. Another nozzle connected to the enclosing hood can be used for feeding air or steam into the hood
25 in order to bring the interior temperature and humidity to a level that prevents the coating mist from depositing and drying onto the interior surfaces of the hood. Finally, the interior walls of the hood can be made coolable, whereby the coating mist will condense on the
30 cooled surfaces.

More specifically, the coating method according to the invention is characterized by what is stated in the characterizing part of claim 1.

35

Furthermore, the applicator apparatus according to the invention is characterized by what is stated in the

characterizing part of claim 15.

The invention offers significant benefits.

5 Air jets employed in the noncontacting supporting of a paper web may replace dryer devices, whereby the dryer section may be made smaller in size and more readily integratable in the layout of the papermaking machine. With the help of the edge deckles according to the
10 invention, the coat profile at the web edges can be made uniform and the cross-machine width of the applied coat can be easily varied. Due to the partial vacuum in the interior of the hood enclosing the nozzles, the coating mist cannot escape from the hood so as to soil equipment
15 exterior to the hood. Furthermore, the adherence and drying of the coating onto the interior parts and surfaces of the hood is reduced thus relaxing the need for their frequent cleaning. Devices specifically intended to the separation of coating solids from the
20 coating mist can be omitted, because of the condensation of solids from the coating mist onto the cooled interior surfaces of the enclosing hood, wherefrom the solids can be recovered for reuse in the coating mix circulation.

25 In the following, the invention will be examined in greater detail by making reference to exemplifying embodiments illustrated in the appended drawings in which

Fig. 1 shows a schematic view of an embodiment of the
30 spray applicator apparatus according to the invention sectioned longitudinally in the travel direction of the paper web.

Fig. 2 shows a schematic cross-sectional view of an
35 applicator apparatus according to the invention, particularly for edge deckles disposed between the spraying nozzles and the paper web.

As shown in Fig. 1, a paper web 2 to be coated enters via a horizontal slit 10 the hood 9 enclosing the applicator apparatus. The spraying nozzles 1 are located below the web 2, while the air-jet nozzles 8 serving to support the paper web 2 are disposed above the web 2. The function of the edge deckles 3 shown in Fig. 1 are illustrated in more detail in Fig. 2. The air-jet nozzles 8 disposed above the paper web 2 inject air against the paper web 2 at an intensity sufficient to compensate for the impingement force imposed on the lower side of the web 2 by the coating jets emitted by the spraying nozzles 1 and, simultaneously, the air jets serve to dry the coating applied from the spraying nozzles 1 to the web 2. The efficiency of the drying effect can be improved by increasing the temperature of the air discharged from the nozzles 8. Via a suction nozzle 7 connected to the wall of the enclosing hood 9, the interior of the hood 9 is brought to a partial vacuum relative to the ambient pressure thus preventing the coating mist from escaping to the exterior of the hood 9. The interior walls of the hood 9 are cooled with, e.g., chilled water circulating in cooler elements 5, whereby the particulate matter of the coating mist floating in the interior of the hood 9 can be condensed on the wall surfaces and recovered therefrom to the coating mix circulation. The interior temperature and humidity of the hood 9 can be set to desired values by feeding moist air or steam into the hood 9 via an infeed nozzle 6 adapted to the bottom of the hood 9.

In Fig. 2 are shown the spraying nozzles 1 of the applicator apparatus, the paper web 2 to be coated, edge deckles 3 and suction nozzles 4 disposed on the edge deckles 3. When the spraying nozzles 1 apply the coating to the lower surface of the paper web 2, the cross-machine width of the area being coated can be delineated

with the help of the edge deckles 3 disposed between the spraying nozzles 1 and the paper web 2. Both the distance of the edge deckles 3 from the surface of the paper web 2 and the cross-machine width of the coated area delineated by the edge deckles 3 can be set to desired values. Thus, coating mist droplets accumulating on the lower surfaces of the edge deckles 3 from the coating sprays emitted by the spraying nozzles 1 can be sucked into nozzles 4 disposed on the edge deckles 3, whereby the droplets are prevented from reaching the surface of the moving paper web 2.

In addition to those described above, the invention may have alternative embodiments.

When the web support is implemented noncontactingly with the help of air jets, the enclosing hood 9 can be made long, whereby a plurality of successive or alternating applicator and dryer stages may be adapted inside the hood 9. The embodiment described above can be modified by disposing spraying nozzles 1 and air-jet nozzles 8 on different sides of the web 2. As required by the travel direction of the web 2, the enclosing hood 9 may be disposed in different positions. Thus, the hood 9 can be oriented, e.g., horizontally or vertically or even in an inclined position. The interior of the enclosing hood 9 can be equipped with deflection devices whose air discharge jets permit the travel path of the web 2 to be directed noncontactingly inside the hood 9. The air jets of the web deflection devices also make it possible to dry the coating applied to the surface of the web 2.

The boundary air layer, which travels on the surface of the moving web 2 and causes disturbance to the application of the coating to the surface of the web 2, can be removed prior to the application point, e.g., with the help of a mechanical doctoring element or by applying air

jets reverse to the travel direction of the web 2. Also the exit slit 11 of the enclosing hood 9 can be sealed by air jets blowing toward the slit, reverse to the travel direction of the web 2, said air jets preventing the coating mist particles from escaping to the exterior of the enclosing hood 9 via its exit slit 11. The suction nozzles 4 connected to the edge deckles 3 may also be routed inside the edge deckles 3 or passed along the inner sides of the edge deckles 3 facing the edge of the paper web 2. The applicator apparatus according to the invention can be run with varied kinds of coating mixes. The coating to be applied to the paper web 2 may also be cooled, whereby the portion of the coating mist not adhering to the web 2 will condense more readily onto the cooled walls of the enclosing hood 9. Besides for coating paper sheet, the invention is obviously also suitable for use in the coating of board and other materials of the kind.

Claims:

1. Method for coating a moving paper web (2), in which method the web (2) to be coated is passed to a coater station and the coating is applied to at least one surface of the moving web (2) by means of spraying nozzles (1) disposed in the interior of an enclosing hood (9), characterized in that the web (2) is supported noncontactingly by means of air jets directed toward at least one side of the web (2).
2. Method according to claim 1, characterized in that the web (2) is supported by heated-air jets for drying the coating applied to the surface of the web (2).
3. Method according to claim 1, characterized in that the coverage of the coating jets directed from the spraying nozzles (1) to the surface of the web (2) is delineated in the cross-machine direction across the web with the help of at least one edge deckle (3) disposed between the spraying nozzles (1) and the paper web (2).
4. Method according to claim 1, characterized in that the interior of the hood (9) is brought to a vacuum in order to prevent the coating mist from escaping to the exterior of the hood (9).
5. Method according to claim 1, characterized in that moist air or steam is fed into the enclosing hood (9).
6. Method according to claim 1, characterized in that the walls of the enclosing hood (9) are cooled in order to cool the coating mist onto the walls thereof.

7. Method according to claim 3, c h a r a c t e r -
i z e d in that coating mix accumulated on the surface
of the edge deckle (3) is removed via a nozzle (4)
5 disposed on the edge deckle (3).
8. Method according to claim 1 or 2, c h a r a c -
t e r i z e d in that the coating is applied to the web
(2) and the web (2) is dried at least in one step in the
10 interior of the enclosing hood (9).
9. Method according to claim 1, c h a r a c t e r -
i z e d in that the travel direction of the web (2) is
deflected noncontactingly by means of at least one
15 deflecting device disposed in the interior of the
enclosing hood (9).
10. Method according to claim 1, c h a r a c t e r -
i z e d in that the boundary air layer traveling on the
20 surface of the moving web (2) is removed prior to the
application of the coating to the web (2) with the help
of a mechanical doctoring element.
11. Method according to claim 1, c h a r a c t e r -
25 i z e d in that the boundary air layer traveling on the
surface of the moving web (2) is removed prior to the
application of the coating to the web (2) by applying air
jets reverse to the travel direction of the web (2).
12. Method according to claim 1, c h a r a c t e r -
30 i z e d in that toward the slit (11) of the enclosing
hood (9) are directed air jets blowing reverse to the
travel direction of the web (2) in order to prevent the
coating mist from escaping to the exterior of the enclos-
35 ing hood (9).

13. Method according to claim 1, c h a r a c t e r -
i z e d in that at least two different kinds of coating
mixes are applied to the web (2).
- 5 14. Method according to claim 1, c h a r a c t e r -
i z e d in that cooled coating mix is applied to the web
(2).
- 10 15. Apparatus for coating a moving paper web (2), said
apparatus comprising spraying nozzles (1) for applying
coating to at least one surface of the paper web (2) and
a hood (9) enclosing the spraying nozzles, c h a r a c -
t e r i z e d by injection nozzles (8) located on at
least one side of the paper web (2) and serving to
15 support the web (2) in a noncontacting manner by means of
air jets.
16. Apparatus according to claim 15, c h a r a c -
t e r i z e d by at least one edge deckle (3) disposed
20 between the spraying nozzles (1) and the web (2).
17. Apparatus according to claim 16, c h a r a c -
t e r i z e d in that the distance between the edge
deckle (3) and the web (2) is made adjustable.
25
18. Apparatus according to claim 16 or 17, c h a r -
a c t e r i z e d in that the cross-machine width of the
coated area delineated by the edge deckle (3) on the
surface of the web (2) is made adjustable.
30
19. Apparatus according to claim 15, c h a r a c -
t e r i z e d by at least one deflecting device adapted
into the interior of the enclosing hood (9) and serving
to deflect the travel direction of the web (2) non-
35 contactingly.

20. Apparatus according to claim 16, c h a r a c -
t e r i z e d in that a suction nozzle (4) is connected
to the side of the edge deckle (3) facing the spraying
nozzles (1).

5

21. Apparatus according to claim 16 or 20, c h a r -
a c t e r i z e d in that a suction nozzle (4) is
connected to the side of the edge deckle (3) facing the
web (2).

10

22. Apparatus according to claim 16, 20 or 21,
c h a r a c t e r i z e d in that a suction nozzle (4)
is adapted inside the edge deckle (3).

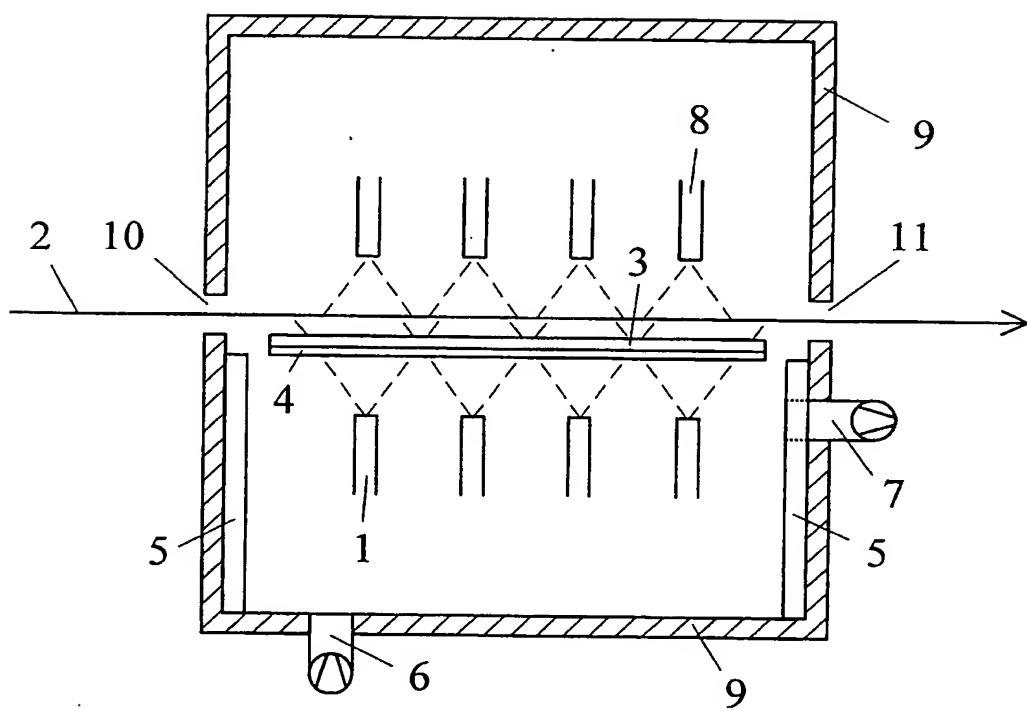


Fig. 1

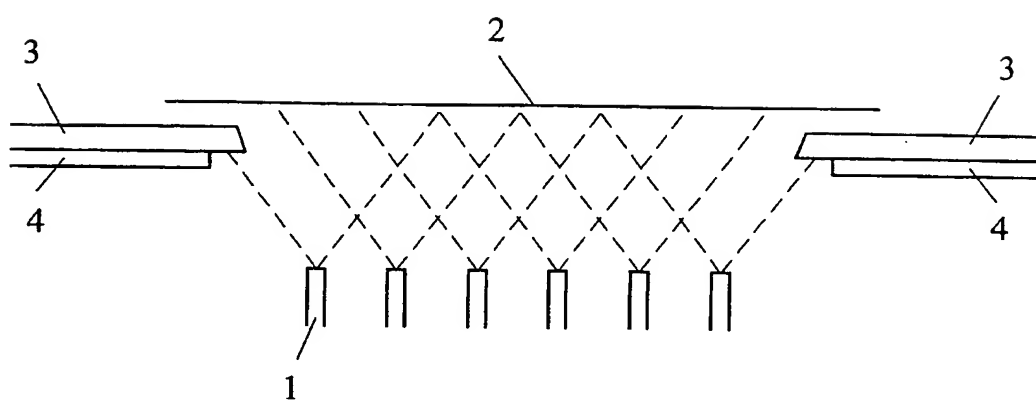


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00026

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21H 23/50

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B05B, B05C, B05D, D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0881330 A2 (VOITH SULZER PAPIERMASCHINEN GESELLSCHAFT MBH), 2 December 1998 (02.12.98) --	1-22
A	US 5849321 A (PEKKA LINNONMAA), 15 December 1998 (15.12.98), abstract --	1-22
A	WO 9832921 A1 (VALMET CORPORATION), 30 July 1998 (30.07.98), page 11, figure 2, abstract --	1-22
A	WO 9713035 A1 (VALMET CORPORATION), 10 April 1997 (10.04.97), abstract --	1-22

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

- * Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
 - "E" earlier document but published on or after the international filing date
 - "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
 - "O" document referring to an oral disclosure, use, exhibition or other means
 - "P" document published prior to the international filing date but later than the priority date claimed
 - "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
 - "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
 - "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
 - "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 April 2000	10 -04- 2000
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Barbro Nilsson/Elis Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00026

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2152848 A (GORDON STEWART PARTINGTON), 14 August 1985 (14.08.85), abstract -- -----	1-3, 15-17

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI 00/00026

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0881330 A2	02/12/98	CA 2238846 A DE 19722159 A JP 10328585 A	27/11/98 03/12/98 15/12/98
US 5849321 A	15/12/98	AT 166119 T CA 2152645 A DE 69502442 D,T EP 0690171 A,B SE 0690171 T3 FI 97247 B,C FI 943191 A JP 8052398 A US 5633044 A	15/05/98 02/01/96 05/11/98 03/01/96 31/07/96 02/01/96 27/02/96 27/05/97
WO 9832921 A1	30/07/98	AU 5866198 A FI 3221 U FI 970340 A,V	18/08/98 22/12/97 28/07/98
WO 9713035 A1	10/04/97	AU 7133496 A AU 7133596 A BR 9610747 A BR 9610768 A CA 2233900 A EP 0856084 A EP 0856085 A FI 954745 A JP 11511379 T WO 9713036 A	28/04/97 28/04/97 13/07/99 13/07/99 10/04/97 05/08/98 05/08/98 06/04/97 05/10/99 10/04/97
GB 2152848 A	14/08/85	NONE	